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MAGNETIC FIELD GENERATOR FOR MRI AND  
METHOD OF COVERING MAGNETIC FIELD  
GENERATOR FOR MRI

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to a magnetic field generator for MRI and a method of covering a magnetic field generator for MRI, and more particularly, to a magnetic field generator for MRI and a method of covering a magnetic field generator for MRI, capable of reducing the time and labors needed for packing or covering to store or transport the magnetic field generator for MRI.

BACKGROUND OF THE INVENTION

[0002] A magnetic field generator using a permanent magnet has very strong magnetism. During storage or transport of the magnetic field generator, a magnetic object, such as rigs, wrench, jack and hammer, would be drawn inside the magnetic field generator, and thereby, the generator would be damaged. Even though the generator is not damaged, if the magnetic object is drawn and left inside the generator, there is a possibility that uniformity of a magnetic field generated by the generator in magnetic resonance imaging (MRI) would become impaired. Accordingly, it is required to surely cover or pack the magnetic field generator.

[0003] As a conventional example, US patent No.6,313,632 B1 discloses a method for packing a magnetic field generator for FRI. However, in US patent No.6, 313, 632 B1, there is a problem that a lot of time and labors are needed for the packing, since many shielding members or packing members are attached to the magnetic field generator by using many studs and/or fixing members.

[0004] Therefore, the objective of the present invention is to provide a magnetic field generator for MRI and a method of covering a magnetic field generator for MRI, capable of reducing the time and labors needed for packing or covering to

store or transport the magnetic field generator for MRI while securely preventing the magnetic object from intruding into the magnetic field generator.

#### DISCLOSURE OF THE INVENTION

[0005] As the first aspect, the present invention provides a magnetic field generator for MRI comprising: a generator main body including a pair of plate yokes opposed to each other with space in between, a pair of magnets disposed in opposed parts of said pair of plate yokes, and a column yoke for magnetically connecting said plate yokes; and a member, made of a non-magnetic material, for covering the whole generator main body.

[0006] As the second aspect, the present invention provides a magnetic field generator for MRI comprising; a generator main body including a pair of plate yokes opposed to each other with space in between, a pair of magnets disposed in the opposed parts of the pair of plate yokes, and a column yoke for magnetically connecting the plate yokes; and a member, made of a non-magnetic material, for covering a top and a side of said generator main body or a side of said generator main body or a bottom and a side of said generator main body.

[0007] As the third aspect, the present invention provides the magnetic field generator according to the first or second aspects, said covering member is made of a mesh of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0008] As the fourth aspect, the present invention provides the magnetic field generator according to the first or second aspects, at least a portion of said covering member, which covers an opening portion of said generator main body, includes a mesh of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0009] As the fifth aspect, the present invention provides the magnetic field generator according to the first or second aspects, said covering member is made of a

closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0010] As the sixth aspect, the present invention provides the magnetic field generator according to the fifth aspect, at least a portion of said covering member, which covers an opening portion of said generator main body, includes a mesh of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0011] As the seventh aspect, the present invention provides the magnetic field generator according to the first or second aspects, at least a portion of said covering member, which covers an opening portion of said generator main body, includes a mesh of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics, and other portion of said covering member is made of a closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0012] As the eighth aspect, the present invention provides the magnetic field generator according to any one of the first to the seventh aspects, further comprising a member for fastening said covering member to said generator main body.

[0013] As the ninth aspect, the present invention provides the magnetic field generator according to the eighth aspect, said fastening member includes a string or a rope made of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0014] As the tenth aspect, the present invention provides the magnetic field generator according to the eighth or ninth aspects, said fastening member is provided on one side of said pair of plate yokes.

[0015] As the eleventh aspect, the present invention provides the magnetic field generator according to the eighth or ninth aspects, said fastening member is provided so as to pass around said covering member.

[0016] As the twelfth aspect, the present invention provides the magnetic field generator according to any one of the eighth to eleventh aspects, said fastening member is removable after said magnetic field generator is transported to a destination thereof.

[0017] As the thirteenth aspect, the present invention provides the magnetic field generator according to the first or second aspects, said covering member is removable after said magnetic field generator is transported to a destination thereof.

[0018] As the fourteenth aspect, the present invention provides a method of covering a magnetic field generator for MRI, having a generator main body including a pair of plate yokes opposed to each other with space in between, a pair of magnets disposed in opposed parts of said pair of plate yokes, and a column yoke for magnetically connecting said plate yokes, comprising steps of: covering the whole generator main body by means of a member made of a non-magnetic material; and fastening said member to said generator main body.

[0019] As the fifteenth aspect, the present invention provides a method of covering a magnetic field generator for MRI, having a generator main body including a pair of plate yokes opposed to each other with space in between, a pair of magnets disposed in opposed parts of said pair of plate yokes, and a column yoke for magnetically connecting said plate yokes, comprising steps of: covering a top and a side of said generator main body or a side of said generator main body or a bottom and a side of said generator main body by means of a member made of a non-magnetic material; and fastening said member to said generator main body.

[0020] As the sixteenth aspect, the present invention provides the method according to the fourteenth or fifteenth aspects, at least a portion of said member, which covers an opening portion of said generator main body, includes a mesh of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0021] As the seventeenth aspect, the present invention provides the method according to the fourteenth or fifteenth aspects, said member is made of a closely

woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0022] As the eighteenth aspect, the present invention provides the method according to the fourteenth or fifteenth aspects, at least a portion of said member, which covers an opening portion of said generator main body, includes a mesh of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics, and other portion of said covering member is made of a closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0023] As the nineteenth aspect, the present invention provides the method according to any one of the fourteenth to eighteenth aspects, said fastening step includes a step of fastening said member to said generator main body using a string or a rope made of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics.

[0024] As the twentieth aspect, the present invention provides the method according to the nineteenth aspect, said member for covering said generator main body and said string or rope are removable after said magnetic field generator is transported to a destination thereof.

[0025] According to the present invention, there is no any connection member, such as studs, between the magnetic field generator and the covering member, which would reduce the time and labors needed to pack or cover the magnetic field generator for MRI for the storage and transport thereof while securely preventing the magnetic object from intruding into the magnetic field generator.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0026] Fig. 1 is a perspective view of a magnetic field generator for MRI of a first embodiment of the present invention, which is covered by a covering member.

[0027] Fig. 2 is a bottom view of the magnetic field generator for MRI of the first embodiment of the present invention, which is covered by the covering member.

[0028] Fig. 3 is a perspective view of the covering member of the first embodiment of the present invention.

[0029] Fig. 4 is a perspective view of a generator main body.

[0030] Fig. 5 is a perspective view of a magnetic field generator for MRI of a second embodiment of the present invention, which is covered by a covering member.

[0031] Fig. 6 is a bottom view of the magnetic field generator for MRI of the second embodiment of the present invention, which is covered by a covering member.

[0032] Fig. 7 is a perspective view of a covering member of the second embodiment of the present invention.

[0033] Fig. 8 is a perspective view of a magnetic field generator for MRI of a third embodiment of the present invention, which is covered by a covering member.

[0034] Fig. 9 is a perspective view of a covering member of the third embodiment of the present invention.

[0035] Fig. 10 is a perspective view of a magnetic field generator for MRI of a forth embodiment of the present invention, which is covered by a covering member.

[0036] Fig. 11 is a perspective view of a covering member of the forth embodiment of the present invention.

[0037] Fig. 12 is a perspective view of a magnetic field generator for MRI of a fifth embodiment of the present invention, which is covered by a covering member.

[0038] Fig. 13 is a perspective view of a covering member of the fifth embodiment of the present invention.

#### BEST MODE TO IMPLEMENT THE INVENTION

[0039] The present invention will be described in more detail in conjunction with embodiments illustrated in their relevant drawings.

[0040] First Embodiment

[0041] Fig. 1 is a perspective view of a magnetic field generator for MRI of a first embodiment of the present invention, which is covered by a covering member.

[0042] As shown in this figure, a magnetic field generator 100 for MRI includes a generator main body 1 and a covering member 10 for covering the whole generator main body 1.

[0043] The covering member 10 may be a large bag having a top part 10t, a side part 10s with a mesh portion 10m, and a bottom part 10b, and is formed so as to wholly cover the generator main body 1 from above. The mesh portion 10m covers an opening portion 1a of the generator main body 1 for enabling one to look in through the mesh portion 10m in order to see the generator main body 1 inside of the covering member 10. The top part 10t, the side part 10s except the mesh portion 10m and the bottom part 10b are made of a non-magnetic material, for example a closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The mesh portion 10m is made of a non-magnetic material, for example a mesh or a net of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The materials of the top part 10t, the side part 10s and the bottom part 10b, and the mesh portion 10m are not limited to the above materials, and any material can be adopted for them, which has strength such that a magnetic object, such as rigs, wrench, jack and hammer, can be prevented from intruding into the magnetic field generator 100 and an internal structure of the magnetic field generator 100 can be protected.

[0044] The top part 10t has four holes 10h for exposing four rings 1c of the generator main body 1, which are provided in an upper plate yoke 1d shown in Fig. 4. These rings 1c are used to lift up the magnetic field generator 100 for MRI. A numeral 1b denotes a leg of the generator main body 1.

[0045] Fig. 2 is a bottom view of the magnetic field generator 100 for MRI, which is covered by the covering member.

[0046] A fastening member 11 fastens the covering member 10 to the generator main body 1 by closing the bottom of the covering member 10 with the bottom part 10b. The fastening member 11 is a string or a rope made of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The material of the fastening member 11 is not limited to the above material, and any material which can fasten the covering member 10 to the generator main body 1, and which has strength such that the magnetic object can be prevented from intruding into the magnetic field generator 100, can be adopted for the fastening member 11.

[0047] A numeral 10r denotes a through hole through which the fastening member 11 passes.

[0048] Fig. 3 is a perspective view of the covering member 10.

[0049] As shown in this figure, the bottom part 10b has a function as a lid to close the bottom of the covering member 10.

[0050] Although the covering member 10 in this figure looks like a self-supported structure, the covering member 10 may not be self-supported structure and may be formed so as to be flexible.

[0051] Fig. 4 is a perspective view of the generator main body 1.

[0052] In this figure, the generator main body 1 is shown without being covered by the covering member. The generator main body 1 includes a pair of plate yokes 1d opposed to each other with space in between, a magnet be disposed in each of opposed parts of the pair of plate yokes 1d, and a pair of column yokes if for magnetically connecting the plate yokes 1d.

[0053] As described, the magnetic field generator 100 for MRI of the first embodiment has a simple configuration, thus reduces the time and labors needed to

pack or cover the magnetic field generator 100 for MRI for storage and transport thereof. Furthermore, since the covering member 10 wholly covers the generator main body 1, it is possible to securely prevent a magnetic object, such as rigs, wrench, jack and hammer, from intruding into the magnetic field generator even in case that the magnetic field generator 100 for MRI is lifted up or is transported to a destination thereof.

[0054] Second Embodiment

[0055] Fig. 5 is a perspective view of a magnetic field generator for MRI of a second embodiment of the present invention, which is covered by a covering member.

[0056] As shown in this figure, a magnetic field generator 200 for MRI includes a generator main body 1 and a covering member 20 for covering a top and a side of the generator main body 1. The covering member 20 may be a large bag having a top part 20t and a side part 20s with a mesh portion 20m and open bottom, and is formed so as to cover the generator main body 1 from above. The mesh portion 20m covers an opening portion 1a of the generator main body 1 for enabling one to look in through the mesh portion 20m in order to see the generator main body 1 inside of the covering member 20. The top part 20t and the side part 20s except the mesh portion 20m are made of a non-magnetic material, for example a closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The mesh portion 20m is made of a non-magnetic material, for example a mesh or a net of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The materials of the top part 20t and the side part 20s, and the mesh portion 20m are not limited to the above materials, and any material can be adopted for them, which has strength such that a magnetic object, such as rigs, wrench, jack and hammer, can be prevented from intruding into the magnetic field generator 200 and an internal structure of the magnetic field generator 200 can be protected.

[0057] The top part 20t has four holes 20h for exposing four rings 1c of the generator main body 1, which are provided in the upper plate yoke. These rings 1c are

used to lift up the magnetic field generator 200 for MRI. A numeral 1b denotes a leg of the generator main body 1.

[0058] Fig. 6 is a bottom view of the magnetic field generator 200 for MRI, which is covered by a covering member.

[0059] Fastening members 21, 22, 23 and 24 fasten the covering member 20 to the generator main body 1 by tying in the bottom portion of the side part 20s. The fastening members 21, 22, 23 and 24 are a string or a rope made of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The material of the fastening members 21, 22, 23 and 24 is not limited to the above material, and any material which can fasten the covering member 20 to the generator main body 1, and which has strength such that the magnetic object can be prevented from intruding into the magnetic field generator 200, can be adopted for the fastening members 21, 22, 23 and 24.

[0060] A numeral 20r denotes a through hole through which each of the fastening members 21, 22, 23 and 24 passes.

[0061] Fig. 7 is a perspective view of the covering member 20.

[0062] As shown in this figure, the covering member 20 has an open bottom. Although the covering member 20 in this figure looks like a self-supported structure, the covering member 20 may not be self-supported structure and may be formed so as to be flexible.

[0063] As described, the magnetic field generator 200 for MRI of the second embodiment has a simple configuration, thus reduces the time and labors needed to pack the magnetic field generator 200 for MRI for storage and transport thereof. Furthermore, since the covering member 20 does not cover the bottom of the generator main body 1, the configuration can be simple more. Additionally, the covering member 20 can be used even turning upside down.

[0064] Third Embodiment

[0065] Fig. 8 is a perspective view of a magnetic field generator for MRI of a third embodiment of the present invention, which is covered by a covering member.

[0066] As shown in this figure, a magnetic field generator 300 for MRI includes a generator main body 1 and a covering member 30 for covering a side of the generator main body 1.

[0067] The covering member 30 may be a large pipe having a side part 30s with a mesh portion 30m, an open top, and an open bottom.

[0068] The mesh portion 30m covers an opening portion 1a of the generator main body 1 for enabling one to look in through the mesh portion 30m in order to see the generator main body 1 inside of the covering member 30. The side part 30s except the mesh portion 30m is made of a non-magnetic material, for example a closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The mesh portion 30m is made of a non-magnetic material, for example a mesh or a net of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The materials of the side part 30s and the mesh portion 30m are not limited to the above materials, and any material can be adopted for them, which has strength such that a magnetic object, such as rigs, wrench, jack and hammer, can be prevented from intruding into the magnetic field generator 300 and an internal structure of the magnetic field generator 300 can be protected.

[0069] Four rings 1c of the generator main body 1 are provided in the upper plate yoke and are exposed at the open top. These rings 1c are used to lift up the magnetic field generator 300 for MM. A numeral 1b denotes a leg of the generator main body 1.

[0070] Fastening members 31, 32, 33 and 34 (and 21, 22, 23 and 24 as shown in Fig. 6) fasten the covering member 30 to the generator main body 1 by tying in the top portion (and the bottom portion as shown in Fig. 6) of the side part 30s. The fastening members 31, 32, 33 and 34 are a string or a rope made of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The material of the

fastening members 31, 32, 33 and 34 is not limited to the above material, and any material which can fasten the covering member 30 to the generator main body 1, and which has strength such that the magnetic object can be prevented from intruding into the magnetic field generator 300, can be adopted for the fastening members 31, 32, 33 and 34.

[0071] A numeral 30r denotes a through hole through which the fastening members 31, 32, 33 and 34 (and 21, 22, 23 and 24 as shown in Fig. 6) pass.

[0072] Fig. 9 is a perspective view of the covering member 30.

[0073] As shown in this figure, the covering member 30 has an open top and an open bottom. Although the covering member 30 in this figure looks like a self-supported structure, the covering member 30 may not be self-supported structure and may be formed so as to be flexible.

[0074] As described, the magnetic field generator 300 for MRI of the third embodiment has a simple configuration, thus reduces the time and labors needed to pack the magnetic field generator 300 for MRI for storage and transport thereof. Furthermore, since the covering member 30 does not cover the top and the bottom of the generator main body 1, the configuration can be simple more. Additionally, the covering member 30 can be used even turning upside down.

[0075] Fourth Embodiment

[0076] Fig. 10 is a perspective view a magnetic field generator for MRI of a fourth embodiment of the present invention, which is covered by a covering member.

[0077] A magnetic field generator 400 for MRI includes a generator main body 1 and a covering member 40 for covering a side of the generator main body 1.

[0078] The covering member 40 may be a large belt having a non-mesh portion 40s and a mesh portion 40m. The mesh portion 40m covers an opening portion Ta of the generator main body 1 for enabling one to look in through the mesh

portion 40m in order to see the generator main body 1 inside of the covering member 40. The non-mesh portion 40s is made of a non-magnetic material, for example a closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The mesh portion 40m is made of a non-magnetic material, for example a mesh or a net of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The materials of the non-mesh portion 40s and the mesh portion 40m are not limited to the above materials, and any material can be adopted for them, which has strength such that a magnetic object, such as rigs, wrench, jack and hammer, can be prevented from intruding into the magnetic field generator 400 and an internal structure of the magnetic field generator 400 can be protected.

[0079] Four rings 1c of the generator main body 1 are provided in the upper plate yoke and are exposed at a top of the magnetic field generator 400 for MRI. These rings 1c are used to lift up the magnetic field generator for MRI 400. A numeral lb denotes a leg of the generator main body 1.

[0080] Fastening members 41 and 42 fasten the covering member 40 to the generator main body 1 by passing around the covering member 40. The fastening members 41 and 42 are a string or a rope made of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The material of the fastening members 41 and 42 is not limited to the above material, and any material which can fasten the covering member 40 to the generator main body 1, and which has strength such that the magnetic object can be prevented from intruding into the magnetic field generator 400, can be adopted for the fastening members 41 and 42.

[0081] Fig. 11 is a perspective view of the covering member 40.

[0082] As shown in this figure, the covering member 40 is wound around the side of the generator main body 1. Although the covering member 40 in this figure looks like a self-supported structure, the covering member 40 may not be self-supported structure and may be formed so as to be flexible.

[0083] As described, the magnetic field generator 400 for MRI of the fourth embodiment has a simple configuration, thus reduces the time and labors needed to pack the magnetic field generator 400 for MRI for storage and transport thereof. Furthermore, since the covering member 40 is a winding type, lifting up the generator main body 1 to attach the covering member 40 thereto is not required.

[0084] Fifth Embodiment

[0085] Fig. 12 is a perspective view of a magnetic field generator for MRI of a fifth embodiment of the present invention, which is covered by a covering member.

[0086] As shown in this figure, a magnetic field generator 500 for MRI includes a generator main body 1 and a covering member 50 for covering a side of the generator main body 1.

[0087] The covering member 50 may be a large belt having a non-mesh portion 50s, a mesh portion 50m and a plurality of fastening members 51, 52 and 53. The mesh portion 50m covers an opening portion 1a of the generator main body 1 for enabling one to look in through the mesh portion 50m in order to see the generator main body 1 inside of the covering member 50. The non-mesh portion 50s is made of a non-magnetic material, for example a closely woven fabric of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The mesh portion 50m is made of a non-magnetic material, for example a mesh or a net of stainless steel, aluminum, copper, nylon, cotton, hemp, flax, rubber or plastics. The materials of the non-mesh portion 50s and the mesh portion 50m are not limited to the above materials, and any material can be adopted for them, which has strength such that a magnetic object, such as rigs, wrench, jack and hammer, can be prevented from intruding into the magnetic field generator 500 and an internal structure of the magnetic field generator 300 can be protected.

[0088] The fastening members 51, 52 and 53 are a fastening tape or a buckle.

[0089] Four rings 1c of the generator main body 1 are provided in the upper plate yoke and are exposed at a top of the magnetic field generator 500 for MRI. These rings 1c are used to lift up the magnetic field generator 500 for MRI. A numeral 1b denotes a leg of the generator main body 1.

[0090] Fig. 13 is a perspective view of the covering member 50.

[0091] As shown in this figure, the covering member 50 is wound around the side of the generator main body 1 and the fastening members 51, 52 and 53 are fixed to counter fastening members 54, 55 and 56. A pair of the fastening members 51 and the counter fastening members 54, a pair of the fastening members 52 and the counter fastening members 55, and a pair of the fastening members 53 and the counter fastening members 56 may be formed of a usual or conventional velcro fastener or velcro strap, respectively. However, they are not limited to the usual or conventional velcro fastener or velcro strap, and may have any structure if it can fasten the covering member 50 to the generator main body 1, and has strength such that the magnetic object can be prevented from intruding into the magnetic field generator 500.

[0092] As described, the magnetic field generator 500 for MRI of the fifth embodiment has a simple configuration, thus reduces the time and labors needed to pack or cover the magnetic field generator 500 for MRI for storage and transport thereof. Furthermore, since the covering member 50 is a winding type, lifting up the generator main body 1 to attach the covering member 50 thereto is not required. Moreover, since the fastening members 51, 52 and 53 are provided integrally with the covering member 50, it is convenient for handling.

[0093] In the above-described embodiments, the mesh portion is provided in the covering member. With regard to the size of the mesh portion, the size is arbitrary if the mesh portion can cover a whole part or a part of the opening portion of the generator main body for enabling one to look in through the mesh portion in order to see the generator main body inside of the covering member.

[0094] Also, the covering member can be formed without the mesh portion or can be formed by the non-mesh portion only.

[0095] The present invention is not limited to the above-described embodiments, and any change, modification or substitution within the spirit of the present invention should be contained in the scope of the present invention.